8.0 Findings and Recommendations

8.0 Findings and Recommendations

The process of high-speed rail implementation will require numerous decisions in areas such as route, technology, and financing mechanisms. The technical studies documented in the previous chapters of this report generated a vast number of facts and figures which can be brought to bear on these decisions. The purpose of this Chapter is to summarize the most relevant facts and figures, and to present recommendations of the Intercity High Speed Rail Commission based on these findings.

At this stage, some decisions are necessarily and properly left open until further into the implementation process. In some cases, decisions will rest on more detailed analyses, as well as economic and other conditions at the time of implementation. The Commission has made specific recommendations where the technical study findings, combined with the Commission's professional judgment and experience as well as public comment, have clearly suggested one alternative over another. Public hearings on a draft of this document were held in October 1996 to give the public an opportunity to express their opinions and have a voice in the decision making process.

The key technical findings and recommendations of the Commission are organized by topic as follows:

- Overall feasibility;
- Technology;
- Alignment or route;
- Station locations;
- Extent and phasing of the system;
- Economic impacts and benefits;
- Financing strategy; and
- Responsibility for planning, constructing, operating, and maintaining the high-speed rail system.

8.1 Feasibility

The Commission embarked on this study with the mandate to determine whether high-speed rail would be feasible in California. Feasibility can be considered from many perspectives, including engineering/technical, environmental, financial, and political. Rather than setting strict feasibility criteria or performance thresholds, the Commission considered each aspect of feasibility separately before arriving at the conclusion of overall feasibility. The question of advisability, not whether high-speed rail can be implemented but whether it should be, is addressed in the Action Plan and Executive Summary of this document.

8.1.1 Engineering/Technical Feasibility

Technical study work has shown that high-speed rail in California is feasible from a technical or engineering standpoint. Technology options capable of 200 mph revenue service are available and operating today with a proven track record of reliability and safety. While California's terrain and seismic conditions present considerable civil engineering challenges, the Corridor Evaluation study outlined a number of technically feasible alignment options and set out design criteria to address seismic and other issues.

8.1.2 Environmental Feasibility

At this stage, there is no reason to believe that high-speed rail is infeasible from an environmental point of view. The technical study work discovered no environmental "fatal flaws". Cost estimates for the system included the cost of mitigating the currently known environmental impacts. Nevertheless, final judgment on environmental feasibility awaits the more detailed analysis that is part of a full fledged environmental documentation process.

8.1.3 Financial Feasibility

Because financial feasibility is so critical to the system's implementation, considerable resources were committed to developing state-of-the-art, reliable ridership and revenue forecasts. Combined with detailed financial analyses, these forecasts showed that high-speed rail is financially feasible, assuming a public base funding source.

The high-speed rail system will generate an operating surplus, a notable achievement in the arena of rail transportation. This operating surplus is large enough to help finance the extensions, but cannot finance the cost of constructing the system as a whole. The analysis to date suggests that public sources will provide the lowest cost and only feasible funding options for the bulk of the system. At the same time, there are ample opportunities for private partners to contribute to the system's financing.

8.1.4 Political Feasibility

High-speed rail implementation will require a dedicated and coordinated effort involving the State, local governments, private partners, and the citizens of California. High-speed rail may be technically, environmentally, and financially feasible but without political will, a project of this magnitude and complexity will never come about.

While political feasibility is a difficult issue to gauge, the Commission believes that high-speed rail could be politically feasible if the project is presented properly. The public has been willing in the past to tax itself to pay for transportation projects. For example, voters approved a 9 cent gas tax increase in 1990 which was not project specific. High-speed rail would be a concrete, highly visible project with a broad array of benefits and could be paid for with as little as a statewide 1/4 cent sales tax.

The Commission recognizes that in order to achieve political feasibility and popular support, the system must be designed for all of California's diverse population. Equal opportunity and participation must be afforded to all in the development of the system.

8.2 Technology

The choice between a magnetic levitation (Maglev) or steel-wheel (VHS) technology will have a profound impact on the system's capital costs as well as its ridership and revenue potential. Technology will affect the levels of service offered to riders, and will impact a number of critical engineering and planning issues. Foremost among these is the interface with existing and future intercity, urban, commuter, and freight rail services.

8.2.1 Findings

Table 8.1 provides a summary comparison of relevant characteristics for both Maglev and VHS technology.

Engineering Issues

- Although extensive research and development has taken place in Germany and Japan, Maglev will not begin revenue service until the year 2006,[1] at the earliest. In contrast, VHS steel-wheel technology has a proven record of revenue service under a wide variety of conditions.

- There are only limited opportunities to use Maglev's superior greater grade climbing capability (10 percent maximum gradient for Maglev vs. 5 percent for VHS) to avoid tunneling and elevated segments along the alignments studied.

[1]The Berlin-Hamburg TransRapid line is slated to begin operations in 2006.

Table 8.1 Comparison of Very High Speed and Maglev Technology

	HS	VHS	Maglev
GENERAL			
• Technology	Steel wheel/steel rail	Steel wheel/steel rail	Magnetic levitation
• Motive Power/Propulsion	Electric traction locomotives with catenary	Electric traction locomotives with catenary	Linear induction motors
OPERATIONS			
• Top Speed	125 - 150 mph	180 - 220 mph	200 - 310 mph
• Average Speed	75 - 95 mph	125 -155 mph	155 - 185 mph
• Acceleration (mph/s)			
– 0 - 60 mph	0.9	1.1	3.1
– 60 - 120 mph	0.5	0.6	1.8
– > 120 mph	0.2	0.2	1.1
• Deceleration (mph/s)	1.8	1.6	1.8
CIVIL			
• Superelevation	6 degrees	7 degrees	16 degrees
• Gradient			
– Maximum	3.0%	3.5%	6.0%
– Absolute Maximum(1)	5.0%	5.0%	10.0%
• Horizontal Curvature(2)			
• Desired Min. Radius at Maximum Speed	6,200 ft @ 125 mph	17,500 ft @ 220 mph	23,300 ft @ 310 mph
• Absolute Min. Radius at Maximum Speed	6,200 ft. @ 125 mph	16,700 ft. @ 220 mph	18,000 ft. @ 310 mph
• For Tilt Technology	4,100 ft @ 125 mph		
• Vertical (Sag) Curvature(2)			
• Minimum Radius at Maximum Speed	34,000 ft @ 125 mph	105,000 ft @ 220 mph	214,200 ft @ 310 mph
• Vertical (Crest) Curvature			
• Minimum Radius at Maximum Speed	52,000 ft @ 125 mph	168,000 ft @ 220 mph	321,500 ft @ 310 mph
• Right-of-way Requirements	50 ft. min.	50 ft. min.	Slightly Less

Notes: (1) Gradients shown represent the capability of the technology group. No high-speed railroad currently operates at gradients over 3.5 percent.

(2) Horizontal and vertical curvatures are limited by passenger comfort and not the physical limitations of the technology.

Source: Parsons Brinckerhoff, 1996.

- VHS can technically share both alignment and track with other *compatible*[2] rail services whereas Maglev will require a separate guideway and platforms. Existing commuter and intercity services could potentially be upgraded to VHS standards, with a potential for cost savings resulting from shared infrastructure.

- As part of its technology evaluation, the Commission examined the potential for commercial freight service. While the equipment used by U.S. freight railroads is far too heavy and slow to be compatible with high-speed rail alignment and operational requirements, there is a market for freight compatible with high-speed operations. This market could include either overnight freight operations using specialized equipment or small package and express mail service. The financing model assumes net freight revenues of $20 million per year.

Ridership and Revenue

- A Maglev system would attract higher ridership and generate more revenue than a VHS system. For example, the SR-99 Base alignment option without extensions would attract 11.2 million passengers and generate $370 million in revenue with VHS technology. With Maglev, the same system would attract 14.9 million passengers and $513 million in revenue.

- Relative to VHS, a Maglev high-speed rail system would derive a larger proportion of its riders from former air passengers and the longer distance Los Angeles-Bay Area market. Maglev would compete more directly with passenger airlines serving the major airports in the Los Angeles and San Francisco markets.

Capital Costs

- Maglev is about 40 percent more costly to build than VHS. A Maglev system on the SR-99 Base alignment would cost $15.8 to 20.7 billion without extensions. A VHS system on the same alignment would cost $11.1 to 16.1 billion.

- Capital cost estimates for Maglev are higher in California than in places such as Germany where seismic safety is not as great a concern.

Environmental Impacts

- Maglev is quieter than VHS operating at the same speed. At top speeds, all technology groups generate about the same level of noise and will require mitigation such as sound walls or speed reduction in sensitive areas. VHS requires overhead catenary structures, whereas Maglev does not. However, Maglev does require at-grade guideway structures which may be more visually obtrusive than VHS track systems.

[2]Compatibility implies coordinated schedules, and compatible equipment design.

Financing Implications

- The higher construction cost of a Maglev system would require a larger base funding source. If financed through an incremental gasoline tax, a Maglev system using the SR-99 Base alignment would require a 6 to 8 cent per gallon increase, compared to the 5 to 6 cent increase required for a VHS system. If funded through a statewide sales tax, Maglev would require a 3/8 cent increase rather than the 1/4 cent increase for VHS.

Economic Impacts

- A high-speed rail system using either technology group would generate a significant and positive economic impact.

Public Opinion

- In general, public opinion has favored VHS technology over the more expensive and untested Maglev. The public has also expressed some concern over elevated structures in urban areas, particularly in the San Fernando Valley.

8.2.2 Recommendations

The Commission focused on systems capable of maximum operating speeds of at least 200 mph, selecting the electric traction Very High Speed (VHS) and magnetic levitation (Maglev) technology families for further consideration. Based upon current knowledge and experience in revenue service, the Commission recommends VHS technology. Beyond this, it is premature to specify a proprietary technology or manufacturer. The choices may be determined by the timing of system implementation: If begun immediately, VHS would be the only technology proven in extensive revenue service. If implementation is a longer-term process, however, future technology developments could make Maglev a more attractive option, particularly if manufacturers step forward with performance guarantees, financial incentives, or other offers.

The Commission further recommends that high-speed trains be separated from other incompatible rail services, such as conventional freight operations. High-speed rail operating revenues should, however, be maximized by carrying freight that is compatible with the requirements of high-speed passenger service.

8.3 Alignment

Based on early cost, ridership, and environmental impact information, the Commission narrowed consideration of major alternatives for the north-south route to the Interstate 5 (I-5) and the State Route 99 (SR-99) Corridors. A Coastal Route was found unable to support speeds adequate to provide competitive travel times in the Los Angeles-San

Francisco Bay Area market. Technical and financial analyses prepared during a subsequent phase of the study led the Commission to further narrow later study efforts to the SR-99 Corridor. The SR-99 Corridor offers higher ridership and revenue potential, can better serve intermediate[3] travel markets, and would divert more automobile travel than the I-5 Corridor, but at somewhat higher capital and operating costs. Furthermore, public opinion expressed to date clearly favors building high-speed rail in the SR-99 Corridor rather than the I-5 Corridor.

In addition to three alignment variations within the SR-99 Corridor, there are numerous options for mountain passes, connections to major metropolitan areas, and system extensions. These options present different combinations of cost, environmental impacts, and levels of service to the passenger.

The SR-99 Base, the SR-99 Short, and the SR-99 Long alignment configurations were developed as statewide alignment scenarios for the technical studies. These combinations are representative scenarios, however, and decisions regarding each aspect of the eventual high-speed rail alignment should be considered separately. Table 8.2 summarizes the relevant characteristics of the three alignment configurations. Findings regarding alignment variations within the SR-99 Corridor, mountain passes, connections to major metropolitan areas, and system extensions are presented in the following sections.

8.3.1 Findings

Central Valley Segment (BNSF, SP, or "New" Alignment Options)

There are three potential alignments within the Central Valley, which would constitute the greater part of a Los Angeles-Bay Area system. The Burlington Northern Santa Fe (BNSF) and the Southern Pacific (SP) Corridors are existing rail alignments. In contrast, the SR-99 "New" Corridor would consist of new right of way, much of it on agricultural land. For each major alignment option, there are low and high cost alignment variations which generally reflect the difference between serving outlying suburban stations versus existing downtown locations.

Table 8.3 summarizes the relevant characteristics of the three Central Valley alignment options.

Engineering Issues

- Engineering issues and environmental impacts related to the Central Valley alignment options stem largely from their relative proximity to urban areas. Construction costs are significantly higher in urban areas since existing streets and roadways require more grade separations and aerial segments.

[3]That is, other than the Los Angeles-San Francisco market.

Table 8.2 Summary Comparison of Alignment Scenarios

	SR-99 Alignments w/o Extensions			SR-99 Alignments with Extensions		
	Short	**Long**	**Base**	**Short**	**Long**	**Base**
Capital Cost Range (1996 millions)[1]						
VHS	$12.2-15.8	$12.1-16.5	$11.1-16.1	$19.1-22.9	$18.3-23.3	$17.3-22.8
Maglev	$16.7-20.3	$17.4-21.4	$15.8-20.7	$26.2-29.9	$25.8-30.2	$24.2-29.6
Length (miles)	398-406	439-448	399-414	606-613	617-627	577-593
Express Travel Time[2] (hours: minutes)						
VHS	2:42	2:49	2:42	4:47	3:40	3:33
Maglev	1:58	2:03	1:57	3:36	2:48	2:42
Annual O&M Costs (1996 millions)						
VHS	$234	$254	$238	$368	$349	$315
Maglev	$238	$259	$243	$375	$356	$321
Annual Ridership (000s)						
VHS	10,724	10,251	11,214	19,757	19,701	21,206
Maglev	14,235	14,117	14,952	26,285	25,782	27,106
Annual Revenue (1995 millions)						
VHS	$364	$333	$370	$647	$630	$690
Maglev	$498	$481	$513	$903	$868	$920

Notes: Ridership and revenue are forecasts for the year 2015.

[1] The SR-99 Short scenario uses the Capitol route to Sacramento. The other scenarios use the LOSSAN and Stockton routes for the extensions.

[2] Times are between Los Angeles and San Francisco Bay Area for the basic system; and between San Diego and Sacramento with the extensions. The SR-99 Short scenario uses the Capitol route to Sacramento.

Table 8.3 Comparison of Central Valley Alignments

	"New" Alignment	Southern Pacific	Burlington Northern Santa Fe
Capital Cost (1996 billions)[1]			
VHS	$2.98	$6.23	$4.04
Maglev	$5.71	$8.90	$6.92
Length (miles) [1]	215	221	236
Cost per mile (1996 millions)			
VHS	$13.9	$28.2	$17.1
Maglev	$26.6	$40.3	$29.2
Annual Ridership and Revenue	no measurable difference	no measurable difference	no measurable difference

Note: [1] Capital costs and alignment lengths are for segments between Bakersfield and Stockton. Costs include stations, contingency, and program implementation add-ons but not vehicles or support facilities.

- Use of existing rail alignments versus a new alignment has significant engineering and cost ramifications. New high-speed tracks or guideway must essentially be constructed from scratch in the existing alignments, since the existing tracks have not been maintained or improved to anything approaching high-speed standards. Moreover, high-speed passenger service cannot share tracks with currently existing freight or intercity trains due to safety concerns and technical incompatibility. Thus, existing freight tracks typically require relocation within the shared right-of-way with crash barriers installed to separate high-speed passenger service from freight trains.[4] These additional costs associated with existing rail alignments more than outweigh the cost of right-of-way acquisition in the Central Valley for new alignment.

- Both the SP and BNSF alignments pass through urban areas in the Central Valley, requiring numerous grade separations and aerial segments to accommodate high-speed service. In contrast, the new alignment would typically bypass the more densely populated areas, reducing the need for grade separations and elevated sections.

- Using a predominantly new alignment is not mutually exclusive with providing service to the traditional downtown centers, however. A hybrid alignment might utilize predominantly new right-of-way between Central Valley cities and then switch to a more urban alignment, possibly using one of the existing rail rights-of-way, upon approach and departure from the downtown station areas.

Ridership and Revenue

- The ridership impact of substituting outlying station locations for downtown stations under the SR-99 Base alignment configuration is less than 1 percent (±50,000 annual trips). The reduction in travel time resulting from serving outlying rather than downtown stations is offset by the increase in time required for passengers to access the stations. This result suggests that ridership and revenue will not vary greatly across the SR-99 Corridor alignment options.

Capital Costs

- A new alignment serving outlying suburban stations is a substantially less expensive option for the SR-99 Corridor. With VHS construction, the cost for segments between suburban Bakersfield and suburban Merced is about $1.6 billion. Grade separations, elevated sections, and the need for crash barriers raise the cost for comparable segments to $4 billion using the SP alignment, which would serve downtown station locations.

[4]The recently-approved merger of the Southern Pacific and Union Pacific railroads may obviate the need for such crash barriers in some cases if freight service is discontinued on certain corridors.

Environmental

- A new alignment would cause fewer noise impacts than either of the existing rail alignments. A new alignment would, however, tend to bisect properties, potentially restricting movement of people, goods, and equipment, increasing agricultural operating costs and/or reducing the efficiency of agricultural operations.

Financing Implications

- The financing plans developed so far have assumed the lowest cost options for the Central Valley alignment, including suburban stations at Bakersfield, Fresno, Merced, and Stockton. Additional funding will need to be identified to serve these cities with downtown stations or to use existing rail right-of-way.

Economic Impacts

- A new alignment would likely have a greater negative impact on land values along the Corridor (not adjacent to station locations) than the SP or BNSF alignments, which remain within existing rail corridors.

Public Opinion

- Public opinion is overwhelmingly in favor of the SR-99 Corridor as the route through the Central Valley. A number of parties have expressed support for alignments serving Central Valley city downtowns.

Southern Mountain Pass

Table 8.4 summarizes the relevant characteristics of the I-5 (Grapevine), Mojave, and Aqueduct Pass options for crossing the Tehachpi Mountains. The Mojave and Aqueduct passes provide for high-speed rail service to the Antelope Valley where the I-5 Pass roughly follows the alignment of Interstate 5 between Los Angeles and Bakersfield.

Engineering Issues

- The I-5 Pass involves the steepest slopes and requires a 5 percent gradient to cross the Garlock fault, one of the most serious earthquake hazards along the route, at-grade. While VHS systems have achieved 5 percent gradients for short distances, continuous operation at 5 percent or more is untested.

- The Aqueduct Pass requires less tunneling and elevated structure than the I-5 but can cross the Garlock fault at-grade only at a gradient 5 percent or more. Currently only the Maglev technology group is capable of achieving greater than 5 percent gradients.

- The Mojave Pass is the longest and generally the most gradual in ascent and descent of the crossings. With a 3.5 percent gradient (well within the capabilities of both VHS and Maglev technology), the San Andreas and Garlock faults can be crossed at-grade and tunneling effectively minimized.

Table 8.4 Comparison of Southern Mountain Passes

	I-5 Grapevine		Palmdale-Aqueduct	Palmdale-Mojave
	5% grade	3.5% grade		
Capital Costs (billions)				
VHS	$2.42	$2.78	$3.08	$3.15
Maglev	$3.35	$3.74	$4.43	$4.52
Length (miles)	80	80	117	114
Cost per mile (millions)				
VHS	$30	$35	$26	$28
Maglev	$42	$47	$36	$38
Gradients				
to minimize tunneling	5.0%		3.5%	3.5%
to cross faults at-grade	5.0%		greater than 5.0%	3.5%
Annual Ridership, (000s)[2]				
VHS	11,214		same as Mojave	10,251
Maglev	14,952			14,117
Annual Revenue (1995 millions)[1]				
VHS	$370		same as Mojave	$333
Maglev	$513			$481
Environmental Impacts	highest		lower than I-5	lower than I-5

Notes: [1] Ridership and revenue figures are forecasts for the year 2015 assuming the SR-99 Base alignment scenario for the I-5 Pass and the SR-99 Long scenario for the Mojave Pass.

- It is unlikely that special flatcars or containerized freight could be carried profitably over continuous 5 percent grades. Such grades would likely limit high-speed freight to express package/mail services.

Ridership and Revenue

- The SR-99 alignment configurations that use the I-5 Pass result in higher intercity ridership and revenue than alignments serving the Antelope Valley.

- For example, with VHS technology the SR-99 Base configuration (using the I-5 Pass) generates 963,000 more passenger trips and $37 million more revenue than the SR-99 Long configuration (which uses the Mojave Pass). The extra intercity ridership gained by serving the rapidly growing Palmdale area is outweighed by the loss of end-to-end travelers due to an increase in travel times.

- There is no measurable ridership or revenue difference between the Aqueduct and the Mojave Pass options.

- Providing service to the Antelope Valley offers the potential to tap into a long distance commuter market between Palmdale/Lancaster and employment centers in the Los Angeles basin.

Capital Costs

- The I-5 Pass is less costly than the Aqueduct and Mojave options, whether engineered for VHS or Maglev technology. For example, at the 3.5 percent grade option, the I-5 Pass costs about $370 million less than the Mojave pass option, if designed for VHS technology. At the 5 percent grade option, the I-5 costs about $700 million less.

- While the I-5 Pass is more costly on a per mile basis because of the tunnels required, its shorter length lowers the overall cost.

Environmental

- The I-5 Pass would have greater impacts on the natural environment involving higher mitigation costs than the other two options.

Economic Impact

- By linking less expensive land in the Antelope Valley to the economies of the San Fernando Valley and downtown Los Angeles, using either the Aqueduct or the Mojave Pass would generate more benefits for the Southern California economy than using the I-5 Pass.

Financing

- Financial plans for the system have been based on the SR-99 Base alignment configuration, which includes the I-5 Pass at 5 percent. If either the Mojave or the Aqueduct Passes are selected, or if the I-5 Pass is constructed with a 3.5 percent grade, additional funds will be required to cover the extra costs involved.

System Planning

- The Antelope Valley routes could more readily connect with a potential high-speed rail service between Las Vegas and Los Angeles, potentially increasing the system's ridership if Nevada service were implemented.

- The Antelope Valley routes could also serve a future Palmdale International Airport site.

Public Opinion

- There is considerable public and local government support for an alignment serving the Antelope Valley via the Mojave or Aqueduct passes. Most cities, counties, and transportation agencies in the Los Angeles region have expressed support for an Antelope Valley alignment. Among those supporting this option are the City of Los Angeles, the Los Angeles County Metropolitan Transportation Authority, and the Southern California Association of Governments.

Northern Mountain Pass (Altamont, Pacheco, and Panoche Passes)

Selection of a northern mountain pass will determine whether Santa Clara County or the northern Central Valley is provided with direct high-speed rail service. The northern pass will also influence terminus locations in the Bay Area and options for extending service to Sacramento. Table 8.5 summarizes the relevant characteristics of the Altamont, Pacheco, and Panoche Passes.

Engineering

- Because of the topography and urbanized character of surrounding areas, the Altamont Pass requires more elevated sections and tunnel segments than the other options. The Panoche Pass traverses milder terrain than the other passes, requiring relatively less cut-and-fill and tunneling. The Pacheco Pass, extending from Los Banos to Gilroy, requires extensive tunnel and elevated segments to maintain design speeds.

Ridership and Revenue

- The SR-99 Base alignment configuration, which incorporates the Altamont Pass, would generate the highest ridership and revenue for a Los Angeles-Bay Area system: 11.2 million annual passenger trips by the year 2015 with $370 million in revenue with VHS technology. The same basic system configuration with Maglev technology would attract 14.9 million annual trips and $513 million in revenue.[5]

[5]These ridership and revenue figures do not include connecting airline passengers.

Table 8.5 Comparison of Northern Mountain Passes

	Altamont	Pacheco	Panoche
Capital Cost (1996 billions)[1]			
VHS	$1.42	$2.14	$2.60
Maglev	$1.76	$2.50	$3.30
Length (miles) [1]	34	34	63
Cost per mile (1996 millions)			
VHS	$42	$63	$42
Maglev	$52	$73	$53
Annual Ridership, (000,000s)[2]			
VHS	11.1	10.8	10.5
Maglev	14.8	14.5	14.0
Annual Revenue (1995 millions)[2]			
VHS	$367	$363	$359
Maglev	$508	$504	$492

Notes: [1] Cost and distance figures are for the mountain pass segment only, and do not reflect total system cost or distance differences.

[2] Ridership and revenue figures are the Year 2015 forecasts for the SR-99 Base (Altamont), SR-99 Short (Panoche Pass), and SR-99 Short with Pacheco Pass alignment scenarios for the San Francisco Bay Area - Los Angeles system and do not include connecting air passengers. Revenue for the Pacheco Pass alternative is estimated based on average fares.

- By comparison, the SR-99 Short alignment configuration, which uses the Panoche Pass, generates 10.7 million annual passengers and $364 million in revenue with VHS technology.

- A variation of the SR-99 Base configuration using the Pacheco Pass results in ridership projections between the original SR-99 Base option (Altamont Pass) and SR-99 short (Panoche Pass.) The Pacheco Pass variation serves a greater portion of the Central Valley and includes a Merced station. Travel times are slightly longer than the Panoche Pass option.

- San Jose could be served by a branch line if the Altamont Pass were selected. This branch would add approximately 700,000 more passengers per year to the ridership of a VHS system using the SR-99 Base alignment configuration.

Capital Costs

- At between $1.4 and 1.7 billion, the Altamont Pass is the least costly of the three northern mountain passes, primarily due to its shorter length. The Altamont and Panoche Passes are roughly equivalent on a cost per mile basis. The Pacheco Pass is the most costly option per mile at $63-73 million per mile.

System Planning

- The Pacheco and Panoche Pass options would provide direct high-speed rail service to the San Jose metropolitan area. If the Altamont Pass were selected, direct service to San Jose would require a branch line.

- The Altamont Pass option would provide direct service to the San Joaquin Valley, and would facilitate extension of service between Sacramento and the Bay Area via Stockton.

Public Opinion

- Public opinion primarily favors the Altamont Pass. Most cities and counties in the Northern San Joaquin Valley have passed resolutions favoring the Altamont Pass. However, the Fresno County Board of Supervisors advocates using the Panoche or Pacheco Pass in order to serve Gilroy and the Highway 101 Corridor to San Jose.

Service to the San Francisco Bay Area

The San Francisco Bay Area can be served from the south via either the Panoche or Pacheco Pass, or from the east via the Altamont Pass. With the Panoche or Pacheco alternatives, service options include continuing from San Jose to downtown San Francisco or San Francisco International Airport (SFO) via the Peninsula, and/or from San Jose to Oakland via the East Bay. With the Altamont Pass, the most likely options are continuing service from Newark across the Dumbarton Bridge then up the Peninsula or simply continuing up the East Bay to Oakland. Under the Altamont Pass scenario, San Jose could be served with a branch line.

Engineering Issues

- Both the Peninsula and East Bay Corridors present considerable engineering and operational challenges due to constrained right-of-way and the presence of existing freight and passenger rail services.

- The Peninsula alignment primarily uses the Peninsula Joint Powers Board (PJPB) right-of-way. This Corridor currently accommodates frequent CalTrain commuter trains that make numerous stops, as well as some freight service. Although this is a highly constrained corridor, opportunities do exist for shared track operations with existing and planned commuter service. However, issues such as electrification, speed of operations, crash worthiness, and institutional arrangements must be first addressed.

- The existing PJPB right-of-way stops short of the financial district/BART connection at the Transbay terminal in San Francisco at 4th and Townsend. Direct service to the Transbay terminal area will require a tunnel, a difficult and costly undertaking.

- There is more freight activity in the East Bay Corridor than on the Peninsula. The at-grade portions of this alignment would require crash walls to separate the freight and high-speed passenger trains.

- The existing East Bay alignment is quite constrained as it enters Oakland in the Jack London Square area. Here, rail, auto, and truck traffic share the same right-of-way for a short distance, an arrangement entirely incompatible with high-speed passenger service. Tunneling through the Embarcadero area to provide the necessary separation of modes and services will be difficult in the soft bay fill.

- A relocated West Oakland BART station could provide the connection to downtown San Francisco from the East Bay.

Ridership

- A Bay Area terminus location in downtown San Francisco would result in higher ridership and farebox revenue than a terminus at either West Oakland or SFO. Using the SR-99 base alignment configuration and VHS technology, a San Francisco terminus would generate about 530,000 more passengers and $18 million more revenue than the same system terminating in Oakland, and about 1.2 million more passengers and $44 million more revenue than a system terminating at SFO.

- A San Jose station would attract about 2.7 million boardings annually with direct VHS service via Panoche or Pacheco Pass.

Capital Costs

- An East Bay alignment between Newark and West Oakland is about $868 million (for VHS construction) to $962 million (for Maglev) less costly to construct than a Peninsula alignment between Newark and downtown San Francisco. The difficult approach to downtown San Francisco accounts for a significant portion of this cost differential.

- If a branch is constructed to connect the Altamont Pass line to San Jose, the capital cost would increase by about $385 million (for VHS construction) to $559 million (for Maglev construction), including the cost of a station in downtown San Jose.

Environmental

- The alignment between San Jose and San Francisco would have greater land use, noise, and vibration impacts than the alignment between Newark and Oakland. As always in urban areas, operating speeds on either side of the Bay would be restricted to about 125 mph to avoid excessive environmental impacts.

System Planning

- The Peninsula Corridor serves SFO, the region's largest and most active airport.

Public Opinion

- While the major Bay Area cities have shown considerable support for high-speed rail, the cities of San Francisco, Oakland, and San Jose all desire direct high-speed service. The City and County of San Francisco and Peninsula cities support the Peninsula Corridor while the City of Oakland and Alameda County have lobbied for the East Bay Corridor.

Service to the Los Angeles Region

The proposed alignment north of Los Angeles Union Station uses the Los Angeles County Metropolitan Transportation Authority's Metrolink right-of-way. The MTA right-of-way serves either the Antelope Valley or Grapevine Pass options through the Tehachapi Mountains and represents the only feasible option to reach downtown Los Angeles from the north.

Engineering Issues

- Operating rights on this alignment are held by Metrolink and Southern Pacific. This right-of-way must accommodate commuter rail, light rail, and freight trains as well as pipeline and fiber optic elements.

- The Corridor is densely developed, with a parallel roadway and numerous roadway crossings at grade.

- While these conditions tend to require aerial structure along parts of the route, an option for maximizing at-grade operations between Union Station and downtown Burbank was explored. This alignment option would run at-grade through the City of Glendale.

Public Opinion

- Issues have been raised by representatives of the San Fernando Valley concerning the use of aerial structures and coordination or compatibility with other services using the Corridor.

System Extensions

Service to San Diego from Los Angeles could follow the existing LOSSAN Corridor or take a more inland route approximating Interstate 15 (see Table 8.6). The extension of service from the San Francisco Bay Area to Sacramento could follow one of two principal routes: the Capitol Corridor or the Stockton Corridor (see Table 8.7).

Ridership and Revenue

- Addition of service to San Diego and Sacramento vastly increases the number of origins and destinations that the system would serve, practically doubling the projected ridership and revenue of the Los Angeles-Bay Area segment.

- As stand-alone segments, the extensions would attract considerably less than the incremental ridership they bring to the combined system.

Capital and O&M Costs

- Capital costs ranges for the extensions vary considerably, depending upon the particular alignment and technology selected.

- Incremental annual operations and maintenance costs of the extensions are approximately $77 million per year for VHS and $78 million per year for Maglev. If operated as a stand alone system, the operating cost of the extension alone would be higher than the incremental cost of operating the extensions as additions to mainline service.

Public Opinion

- Extending the high-speed rail system to include San Diego and Sacramento has received widespread support. Several parties from these regions have emphasized that service to San Diego and Sacramento should be considered an integral part of the system, rather than second tier extensions.

San Diego Extension (LOSSAN Corridor, I-15 Corridor Options)

Ridership and Revenue

- The ridership potential of the LOSSAN and I-15 Corridors is comparable.

Table 8.6 Comparison of San Diego Extension Options

	LOSSAN Corridor	I-15 Corridor
Capital Cost (1996 billions) [1]		
VHS	$4.5-4.7	$5.9-6.0
Maglev	$6.0-6.1	$7.8-7.9
Length (miles) [1]	119-120	158-159
Annual Ridership, (000,000s)[2]		
VHS	3,078	3,106
Maglev	3,314	3,335
Annual Revenue (1995 millions)[2]		
VHS	$73.4	$75.6
Maglev	$79.6	$81.7
Environmental Impacts	high	high

Notes: [1] Capital costs and distances include segments between Los Angeles and San Diego.

[2] Ridership and revenue figures are forecasts for the year 2015 for the San Diego extension operating as a stand alone system.

Table 8.7 Comparison of Sacramento Extension Options

	Capitol Corridor	Stockton Corridor
Capital Cost (1996 billions)[1]		
VHS	$2.4	$1.7-2.1
Maglev	$3.5	$2.4-2.8
Length (miles)[1]	88	58-60
Annual Ridership, (000s)[2]	1,253	2,046
VHS	1,345	2,264
Maglev		
Annual Revenue (1995 millions)[2]		
VHS	$28.0	$45.9
Maglev	$30.4	$51.7
Environmental Impacts	moderate	moderate

Notes: [1] Capital costs and distances include segments between Oakland and Sacramento for the Capitol Corridor and between Stockton and Sacramento for the Stockton Corridor.

[2] Ridership and revenue figures are preliminary forecasts for the year 2015 for the Sacramento extension operating as a stand alone system. Ridership is between San Jose and Sacramento for the Capitol Corridor and between San Francisco and Sacramento for the Stockton Corridor.

Engineering Issues

- The LOSSAN Corridor is an existing rail alignment which accommodates intercity and commuter rail services. The LOSSAN Corridor becomes very congested as it approaches downtown San Diego, being utilized by intercity passenger service, freight service, and an electrified light rail transit line. The LOSSAN Corridor is densely developed in the Los Angeles and San Diego metropolitan areas, with many at-grade crossings and grade separations.

- Implementing high-speed service in the LOSSAN Corridor between San Clemente and San Diego will present special difficulties due to the alignment's proximity to the ocean front.

- Due to the above-described conditions, operating speeds in the LOSSAN Corridor will be restricted to between 90 and 125 mph for steel-wheel-on-rail operations and between 125 and 155 mph for Maglev operations.

- The I-15 Corridor follows the Metrolink route from Los Angeles to Riverside and continues south along I-215 and I-15 to the San Diego metropolitan area. The I-15 Corridor faces significant constraints due to development and terrain along its length. The approach to San Diego is particularly constrained.

Capital and O&M Costs

- The LOSSAN Corridor is the least costly option for the San Diego extension. Primarily because of its shorter length, the LOSSAN Corridor is $1.2 billion to $1.5 billion less expensive than the I-15 Corridor. Costs range from $4.5 to 4.7 billion for the LOSSAN Corridor compared to $5.9-6.0 billion for the I-15 Corridor.

Environmental Impacts

- The LOSSAN Corridor to San Diego has many environmental constraints which preclude VHS passenger service at 200 mph. The significant upgrades required to integrate the Corridor into the high-speed rail system potentially result in fairly severe environmental impacts including restricted beach access, public safety concerns, and visual impacts from the overhead catenary and other structures.

- The I-15 alignment, which travels further inland, would also rank high in most impact categories including impacts to habitat, wetlands, water resources, and residential property impacts.

Financing

- The financing plans assume the less costly LOSSAN Corridor. Selection of the I-15 Corridor would require additional funding to cover the $1.4 billion additional capital costs.

Public Opinion

- In the past, communities along the LOSSAN Corridor have voiced considerable opposition to proposals for high-speed rail. This opposition seems likely to continue as San Diego County communities and environmental groups have written the Commission to oppose the concept of high-speed rail in the LOSSAN Corridor. There is, however, support for continuing to improve and upgrade the existing conventional service in the Corridor. Moreover, representatives of the Inland Empire have advocated the I-15 Corridor in letters and resolutions of support.

Economic Impact

- The LOSSAN option for service to San Diego may cause adverse land value impacts along beachfront areas, as well as in densely developed areas.

- The I-15 Corridor, while currently less developed than the LOSSAN Corridor, exhibits more development potential.

Sacramento Extension (Capitol Corridor and Stockton Corridor Options)

Ridership and Revenue

- The Stockton Corridor option (when part of a San Francisco-Sacramento extension) attracts higher ridership than the Capitol Corridor (which would be part of an Oakland-Sacramento extension) by about one million additional annual passengers.

Engineering Issues

- The Capitol Corridor is an existing intercity rail alignment carrying freight traffic as well as long distance AMTRAK and intrastate *Capitol* service. The existing alignment is severely constrained by development, topography, and circuitous routing along and across San Pablo Bay, from approximately Richmond to Benicia. The widening or geometric improvements required to attain high-speed service would significantly increase the capital costs for this option, above those presented in this report and the supporting technical documents.

- The Stockton Corridor could follow either of the existing Southern Pacific (SP) or Union Pacific (UP) alignments from Stockton to Sacramento. Both alignments currently accommodate freight traffic. The SP alignment is used by the *San Joaquin* passenger trains between Stockton and Oakland via Martinez. This alignment is constrained by encroaching development, grade crossings, and grade separations in urban areas. A low-cost new corridor option bypassing the urbanized area of Stockton could reduce the impact of these constraints to some degree.

Capital and O&M Costs

- For the Sacramento extension, the Stockton Corridor is $350 million to $1 billion less expensive than the Capitol Corridor. Capital costs for a VHS extension to Sacramento range from $1.7 billion to $2.4 billion. The cost for Maglev service runs from $2.4 -$3.5 billion. Costs per mile for the two options are about the same, but the Stockton Corridor is about 45 miles shorter.[6]

Environmental Impacts

- In contrast to the San Diego extension, both options for the Sacramento extension would result in only low to medium impacts.

Financing

- The financing plans assume the Stockton Corridor with a suburban station, at a capital cost of $1.7 billion. The Capitol Corridor, at $700 million more, would require a larger base financing source.

Economic Impact

- The Stockton Corridor would have a more immediately measurable impact on economic development potential than the Capitol Corridor, which for much of its length is built out or otherwise not developable.

- Right-of-way preservation will be necessary if a new alignment in the rapidly developing Stockton Corridor is to remain an option for the Sacramento extension.

- The Stockton and Capitol Corridors serve significantly different populations, in terms of factors such as demographics, socioeconomic characteristics, and historic employment base.

System Planning

- If the Altamont Pass is selected for the northern mountain crossing, the Stockton Corridor option provides a more direct and less expensive extension to Sacramento.

Public Opinion

- Stakeholders advocating an Oakland terminal station also support using the Capitol Corridor for service to Sacramento. Representatives from Sacramento have advocated including service to Sacramento as part of the initial implementation phase.

---

[6]The Stockton Corridor is measured from Stockton to Sacramento while the Capitol Corridor is measured from Oakland to Sacramento.

8.3.2 Recommendations

The Commission has concluded that the data generated by the technical studies are sufficient and compelling enough to support certain alignment recommendations. Although the Commission is making the following corridor recommendations, the final selection of an alignment is dependent upon preliminary engineering, design and the environmental clearance process. The Commission recognizes that retaining some degree of flexibility until later stages of project development is critical. Based on the information gathered to date, the Commission recommends:

- That the route in the Bay Area extend from the Altamont Pass to Newark, where the high-speed line will split into two branches, one crossing the Dumbarton Bridge and serving a downtown San Francisco terminal via the Peninsula, the other serving San Jose;
- Service to Oakland via a connection with BART;
- An extension to Sacramento via the Stockton Corridor;
- An extension to San Diego via an inland alignment (the I-15 Corridor); and
- That development of the alignment approaching Los Angeles Union Station from the north be coordinated with other existing rail services while maximizing at-grade operations.

The Commission conditionally recommends:

- An Antelope Valley alignment for crossing the Tehachapis, as long as significant local incentives are in place and increased economic benefits remain apparent .

Decisions on the more detailed aspects of alignment and route should be postponed until further into the implementation process.

8.4 Station Locations

While 29 station service areas and 47 alternative station site locations were evaluated as part of the Corridor Evaluation study, the actual number of stations constructed for system will be far fewer. Furthermore, the stations between the northern and southern termini will receive different levels of service. Not every train will stop at every station.

In the Central Valley, a key issue is the choice between stations located within the existing downtowns and outlying stations closer to newer urban development. Substantially different capital costs apply to the two alternative strategies, somewhat different travel markets are served, and the accessibility characteristics are quite different.

Within the urban areas, there are further choices for the appropriate station location, such as downtown Burbank vs. Burbank Airport, downtown Los Angeles vs. LAX, and central Palmdale vs. a Palmdale International Airport site.

8.4.1 Findings

- Station locations and service patterns were assumed for developing operational cost estimates and ridership forecasts. These station locations and service patterns constitute a reasonable and representative scenario but should not be construed as a recommendation from the Commission or an "optimal" configuration.

- Station service areas were evaluated on proximity to key population and employment centers, proximity to high growth areas and/or major recreational areas, potential to serve key travel markets, accessibility by auto, and the potential to interconnect with other travel modes. The results are documented in *Candidate High Speed Rail Stations and Intermodal Connectivity.*

- Within each station service area, alternative potential station sites were evaluated on their relation to proposed alignments, proximity to key activity centers, accessibility by auto, potential to interface with public transportation, compatibility with existing and proposed land use, minimization of displacement and other impacts, land availability, relationship to ridership market catchment area, and local and regional policy direction. These evaluations are also documented in *Candidate High Speed Rail Stations and Intermodal Connectivity.*

- Downtown sites in Bakersfield, Fresno, Merced, Modesto, and Stockton rated higher than suburban site options in these cities when evaluated on the above-described factors. These downtown locations involve higher capital costs, however.

- Other favorable sites in station service areas with multiple site options include Burbank Airport, Santa Clarita at I-5, Visalia, Union City, Redwood City, Irvine Transportation Center, and Anaheim.

- A southern terminus at downtown Los Angeles Union Station rather than LAX would result in higher ridership and farebox revenues and lower capital, operating, and maintenance costs. The Los Angeles Union Station terminus has greater public support, and would more readily support future extensions of service to San Diego.

- A northern terminus in downtown San Francisco would generate higher ridership and revenue than terminating the system in Oakland or at SFO.

Public Opinion

- Central Valley residents, as well as local and regional governments, support service to existing downtowns rather than to new outlying station locations.

- Public opinion in Southern California has favored the selection of Union Station and the alignment through the LA Basin from the north. Several parties have requested consideration of Glendale as a station.

8.4.2 Recommendations

The Commission recognizes that very specific decisions on station areas and sites should be made at a later stage of implementation, based on more detailed engineering and economic analysis and with the input of local and regional authorities. At this stage, the Commission has been able to make the following general recommendations:

- In the San Francisco Bay Area, terminal stations located in downtown San Francisco and downtown San Jose;
- Los Angeles Union Station as the preferred Los Angeles area terminus over Los Angeles International Airport (LAX);
- Future consideration of a means of connecting a potential LAX Station with Union Station;
- Future consideration of Glendale as a possible high-speed rail station location; and
- Downtown stations in San Diego and Sacramento.

8.5 Extent and Phasing of System

SCR 6 specified that the Corridor linking the San Francisco Bay Area to the Los Angeles metropolitan area receive first priority in development of the high-speed rail system. However, analysis has shown that the proposed extensions are very promising in terms of the ridership served and revenue generated. In fact, the extensions are critical to the economic and financial feasibility of the system. At issue here is whether the extensions to San Diego and Sacramento should be left as options for future consideration, incorporated as an integral part of the high-speed rail system, or developed as the initial segments of the system.

8.5.1 Findings

There are at least four possible alternative phasing scenarios involving the main Los Angeles-San Francisco segment and the northern and southern extensions, as follows:

1. **Main segment or basic system first, followed by extensions to Sacramento and San Diego.** This is probably the most intuitive of the possible phasing scenarios, and the most directly responsive to SCR 6. Moreover, this scenario would allow project

revenues from the Los Angeles-San Francisco segment to finance the construction of the extensions.

2. **Extensions first, followed by completion of the main segment.** Consideration of this "extensions first" scenario has been triggered by the impressive incremental ridership and revenue-generating characteristics of the San Diego and Sacramento extensions. The extensions, operating as stand-alone services without the Los Angeles-San Francisco segment, would attract on the order of 3 million passengers per year on the San Diego extension and 2 million passengers on the Sacramento extension. The extensions generate 12 to 16 million more annual passengers when added to the basic Los Angeles-San Francisco system.

3. **Main Los Angeles-San Francisco segment only,** in which the extensions are not considered in the overall implementation plan. Under this scenario, existing rail services serving Sacramento and San Diego would act as feeders to the high-speed rail system.

4. **A South-to-North progression,** starting with the ridership-rich Los Angeles-San Diego Corridor, followed in turn by the Los Angeles- San Francisco segment, and finally the Sacramento extension. A variation of the "extensions first" option, this would capitalize on the higher-ridership segments first. As a first demonstration project, the San Diego extension might successfully build support for a more complete system, and might attract a larger percentage of private sector financing.

Unlike other corridors in the proposed system, the LOSSAN Corridor has the added attraction of being suitable for incremental improvement and would not necessarily require a large capital investment up front. On the down side, operational speeds would be limited to about 150 mph (with an average speed of about 100 mph) for environmental reasons. This would make the choice of technology more difficult, since operating speeds would be constrained below the capabilities of both VHS and Maglev technologies.

8.5.2 Recommendations

Of the possible phasing scenarios, only the third (the main segment without extensions) can be ruled out at this stage as several analyses have shown the extensions to be vital to the feasibility of the project. The Commission recommends that the high-speed rail system encompass California's major metropolitan areas: San Diego, Los Angeles, the San Francisco Bay Area, and Sacramento. To take advantage of financing supported by project revenues, the system was envisioned as being constructed in two phases over an eight-year period. The first phase, estimated to take five years, is construction of the Los Angeles-San Francisco Bay Area segment. In the second phase, the links to San Diego and Sacramento would be completed within three years. Beyond this, the Commission recognizes that the exact phasing of system implementation will largely rest on financial considerations and political feasibility. System phasing and cash flow will have to be revisited in more detail at later stages of project implementation.

8.6 Economic Impacts

Ultimately, the merits of the proposed high-speed rail system depend on its economic impacts. The system will have positive impacts such as jobs generated, greater economic output, enhanced competitiveness and quality of life, and reduced dependence on petroleum resources. However, there are costs involved in the system which must be considered as well. The real issue here is whether the resulting benefits justify the public resources that will be dedicated to the system.

8.6.1 Findings

- The economic impact analysis was based upon a representative system configuration consisting of the SR-99 Base alignment from Los Angeles Union Station to downtown San Francisco, with extensions to both San Diego and Sacramento. Both Maglev and VHS technology options were considered. Table 8.8 highlights some of the economic impacts of the system.

- High-speed rail in California is economically feasible. Benefit/cost ratios of the system with the extensions to San Diego and Sacramento are 1.32 for VHS technology and 1.34 for Maglev. The extended system shows an attractive constant price level rate of return of 8.6-8.8 percent.

- A basic Los Angeles-San Francisco system is on the margin of feasibility with a benefit/cost ratio of 0.95 for VHS technology and 1.00 for Maglev.

- High-speed rail would afford significant annual cost savings deriving from the air, highway, and conventional rail modes. The annual cost savings for the year 2020 are $1.1 to $1.4 billion for an extended system, depending on the technology.

- Significant benefits would also accrue to the users of high-speed rail. Also known as consumer surplus, these benefits would range from $515 million to $835 million for an extended system in the year 2020.

- The California economy is better off with high-speed rail:

  - The construction of the high-speed rail system between the years 2000 and 2008 will create 314,000 person-years of additional direct and indirect employment with VHS technology and 450,000 additional person-years of employment with Maglev.

  - Development and operation of the high-speed rail system would substantially increase the California Gross Regional Product (GRP) over the "no-build" scenario. The cumulative net GRP increase from 1998 through 2020, expressed in undiscounted 1996 dollars is $7.7 billion with VHS technology and $10.3 billion with Maglev.

Table 8.8 Economic Impact Summary[1]

	Basic Los Angeles-San Francisco System		With Extensions	
	VHS	**Maglev**	**VHS**	**Maglev**
Net Present Value (1996 millions)[2]	($371)	$49	$3,320	$4,992
Internal Rate of Return	6.72%	7.03%	8.64%	8.79%
Benefit/Cost Ratio	0.95	1.00	1.32	1.34
Year 2020 User Benefits (1996 millions)	$249	$433	$515	$835
Year 2020 Savings to Other Modes (1996 millions)	$604	$769	$1,112	$1,390

Notes: [1] Economic impacts presented in this table assume the SR-99 Base alignment with the LOSSAN Corridor for service to San Diego.

[2] Cumulative costs and benefits over the period between 2000 and 2050, discounted at 7 percent.

Source: Economic Research Associates, 1996.

- After the year 2020, the economic impacts will be positive and steadily increasing as the mobility benefits of high-speed rail take effect.

- High-speed rail will contribute to lower average housing costs in California. Since the California economy is very sensitive to housing costs, the small (about 0.4 percent for VHS Technology) change in average housing costs improve California's competitive position with respect to other states, and registers as an increase in employment or GRP.

- The benefit of increased employment is more noticeable in the Central Valley, where historic unemployment rates are significantly higher than in the urbanized counties of the Los Angeles and San Francisco metropolitan areas.

- The system could generate additional pressure for the conversion of productive agricultural land in the Central Valley into residential or non-agricultural commercial uses. With the appropriate land use and planning policies, however, high-speed rail could also help encourage more dense development patterns, accommodating the same amount of growth with less farmland conversion.

8.6.2 Recommendations

The Commission has found that the projected economic impacts of high-speed rail in California are positive, and sufficiently promising to justify proceeding with high-speed rail implementation. Moreover, there are unquantified but very important benefits associated with high-speed rail that warrant further consideration. These benefits include reduced dependence on imported oil, the addition of valuable extra capacity in the transportation network, and benefits to California's image as a progressive, high-technology state.

8.7 Financing Strategy

Financial models have shown that farebox and other revenues will not be sufficient to fund the system's capital costs. Constructing the system will require the designation of additional revenue sources. The financial analysis studied three levels of financial support including base funding sources, major supplemental funding sources, and supplemental financing. The details of the financing plan will necessarily evolve over the implementation process, so the recommended financing plan should not be thought of as the final word, but rather as a part of a logical and feasible road map for implementation.

8.7.1 Findings

- While system revenues are projected to exceed operating costs, the operating surplus generated is not sufficient to serve as the base funding source (system revenue from the system with extensions can, however, support much of the cost of serving Sacramento and San Diego). Given the current pricing of competing modes, high-speed rail cannot attract a large enough market share or charge high enough prices to generate the level of revenue required to support the bonds which would fund system construction. It is thus necessary to look to other public and private funding sources for construction of the system.

Role of Public Financing

- The base funding analysis (and the failures of the Texas, California-Nevada, and original Florida[7] projects) underscores the need for large public funding of capital costs. Because the environmental hurdles are extensive, it is unlikely a private contractor will be willing to put significant funds at risk during the development stage. Accordingly, a private concession without substantial public funding does not appear feasible.

- The tax-exempt status of revenue bonds supported by a gas tax or other revenue-generating tax must be protected. The financial analysis concludes that the system is not financially feasible without this tax-exempt status. This constraint must be observed when considering institutional arrangements, such as public/private partnerships, which might jeopardize the tax-exempt status. Also, the probability of voter approval of the funding mechanism must be considered when evaluating funding alternatives.

Base Financing Mechanisms

- Seven possible sources were evaluated as candidates for the base funding source. Three have emerged as the most viable:

    1. Motor vehicle fuel tax (gasoline and diesel used for transportation purposes) levied statewide on a *per gallon* basis ("gas tax");

    2. Statewide retail sales tax; and

    3. Retail sales tax levied only in the counties served by the rail corridor.

- Implementation of any of these base funding sources requires approval of both the legislature and voters.

[7]This reference is to a previous, unsuccessful attempt to implement high speed rail, and should not be confused with the current implementation effort now underway in Florida.

- Other mechanisms were also considered, including airport passenger facility charges, highway tolls, and others. These other concepts are not viable for a variety of reasons, primarily because they would not generate sufficient revenue to finance the system.

Major Supplemental Funding Sources

- Four major secondary funding sources for high-speed rail are recommended and included in the financial plan. These are right of way dedications, local agency contributions (through land use regulation such as tax increment financing), vendor/developer financing, and project revenue bond financing. Of the four sources, project revenue financing can provide the most money for construction. For example, project revenue financing is projected to raise $4.0 billion for construction of the VHS system with extensions, assuming a sales tax base funding source.

Supplemental Financing

- Supplemental funding sources adopted for the financial plan are U.S./Cross Border Leveraged Leasing of rail equipment and cash flow interest earnings.

8.7.2 Recommendations

Based on the present financial analysis, the Commission recommends that implementation proceed under the assumption of a public base funding source. This funding source will be used to back tax-exempt revenue bonds, the proceeds of which will fund system construction. The selection of a particular public funding mechanism and development of a complete financing package, including secondary and supplemental funding sources, should occur closer to actual implementation. In developing the high-speed rail financing plan, the Commission stresses the need to maximize private financing contributions and funding opportunities, to seek out local government participation and contributions, and to explore removing institutional barriers to more creative financing techniques. In short, the need for State funds should be reduced to the greatest extent possible.

8.8 Ownership and Operation

This issue concerns the selection of a public-private partnership model and designation (or creation) of a public agency to oversee the high-speed rail implementation process. These decisions will have fundamental implications for legal jurisdiction over the project, responsibility for obtaining environmental clearances, and distribution of risk and liability. There are also critical public policy issues involving the Authority to set fares, system service patterns, and financing methods. The importance of maintaining tax-exempt status for the public/private entity, whatever the form, must be underscored again, as the system as presently evaluated is not financially feasible without this tax-exempt status.

Options for an agency or authority to oversee high-speed rail implementation include:

- An existing State agency;
- A joint powers authority; or
- A special authority.

Options for the project delivery mechanism include:

- Traditional public works procurement,
- Design-build or design-build-operate contracting with primarily public financing; and
- Private concession to design-build-operate with substantial, limited, or no government financial commitment.

8.8.1 Findings

- There is currently no public agency with the experience and resources to construct a technologically advanced system without major private sector participation.
- Advanced and unique system technology requires shifting the technology risk to the private sector through long term performance and operations warranties.
- Design-build-operate contracting or concession with some private sector financing will incentivize on-time, on-budget construction and shift to the private party a large degree of financial risk from construction delay, once environmental clearances and permits are received.
- A key public policy distinction between design-build and concession approaches concerns the degree of control over fare-setting and optimization of ridership/revenue tradeoffs. To the extent the private sector assumes operating revenue risk under a concession arrangement, it will likely demand a role in fare-setting, notwithstanding the potential adverse effects of revenue-maximizing fare structures on ridership.

8.8.2 Recommendations

Given the nature of the project, the Commission recommends creation of a special authority to oversee high-speed rail implementation. This authority should oversee implementation under a design-build or design-build-operate contracting relationship with a private sector entity. As outlined in the financial analysis, the bulk of the project funding will come from public sources but the private partner will share development risk in the form of performance guarantees and warranties.

The recently enacted Senate Bill 1420 (SB 1420) created such a new special authority with the mandate to direct the development and implementation of intercity high-speed rail service in California. The new High Speed Rail Authority is to prepare a plan that would lead to construction and operation of a high-speed rail train network for the State, consistent with and continuing the work of the present Commission. Upon completion, the plan shall be submitted to the Legislature and the Governor for approval by the enactment of a statute or to the voters of the State for approval.

The Commission supports the provisions of Senate Bill 1420 and the creation of a new High Speed Rail Authority. The Commission strongly recommends that there be some continuity in membership between the present Commission and the new Authority. Such continuity will help ensure that the new Authority does indeed build upon the present Commission's work Further details concerning the High Speed Rail Authority and high-speed rail implementation may be found in the *Action Plan* (Chapter 9.0 of this report).

8.9 Summary of Recommendations

The purpose of this section is to set out in as much detail as possible the Commission's vision of where the system should run and how it should operate. The Commission believes that for high-speed rail to move forward, it is necessary to start with such a concrete vision and then adjust it as necessary. The Commission intends that the system recommended in this *Executive Summary* and in the *Summary Report and Action Plan* to serve as a blueprint for high-speed passenger rail in California, which may be modified at later stages of the project implementation process. It is critical to retain some degree of flexibility until the project is environmentally cleared and an agreement has been negotiated with a private partner. Thus, final route selections ultimately will be the responsibility of the High Speed Rail Authority. Table 8.9 summarizes some of the major characteristics of the recommended system.

The recommended system is almost 680 miles long and links all of California's major population centers: Sacramento, the San Francisco Bay Area, the Central Valley, Los Angeles, and San Diego (see Figure 8.1). As shown, the Los Angeles-San Francisco Bay Area segment extends from Los Angeles Union Station in Southern California to northern termini in the downtowns of San Francisco and San Jose. The route crosses the Tehachapi Mountains via an Antelope Valley route and serves the Central Valley with an alignment in the vicinity of SR-99. South of Stockton, the route enters the Bay Area via the Altamont Pass. Once within the Bay Area, the main line branches at Newark with one branch continuing across a newly constructed Dumbarton rail bridge and up the Peninsula (using the Joint Powers Board right-of-way) to downtown San Francisco. The other branch continues south from Newark to San Jose. An alignment from Stockton connects Sacramento to the system. Service between Los Angeles and San Diego utilizes an inland route approximating I-15 and serving San Bernardino and Riverside Counties.

Table 8.9 Recommended System Characteristics[1]

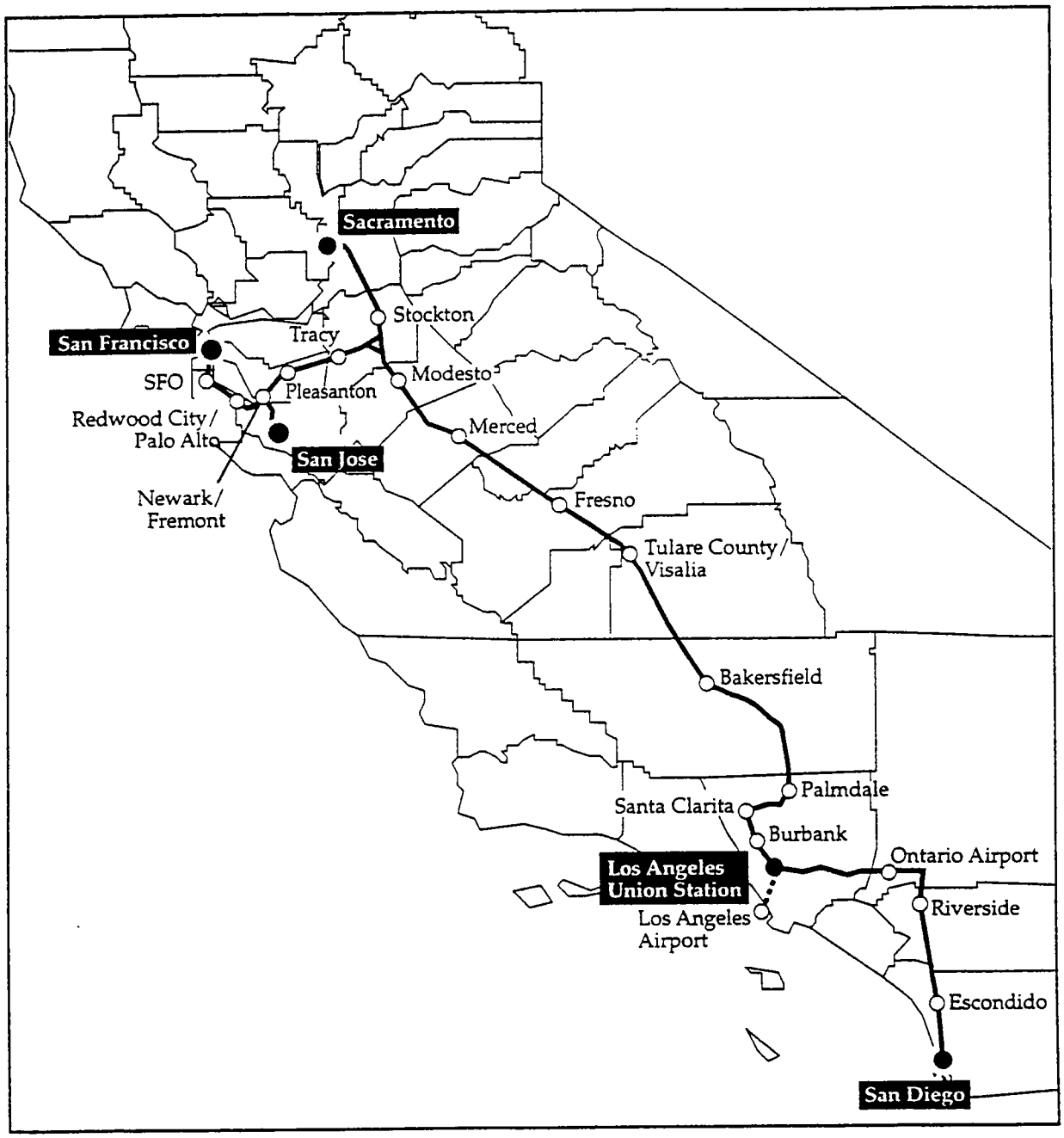
	VHS System	Maglev System
Capital Cost (1996 $billion)		
Los Angeles - San Francisco/San Jose[2]	$11.7	$17.3
Los Angeles - San Diego	6.0	7.9
Stockton - Sacramento	1.7	2.4
Vehicle Cost	1.0	1.0
Support Facilities	0.3	0.3
Total	**$20.7**	**$28.9**
Ridership (Year 2015 Passenger Trips, millions)		
Los Angeles - San Francisco/San Jose	10.6	14.8
With Extensions	19.8	26.4
System Revenue (Year 2015, 1996 $million)		
Passenger (Recommended System)	$634.0	$892.0
Net Freight	$20.5	$20.5
Net Concession	$2.4	$2.4
Total	**$656.9**	**$914.9**
Annual O&M Costs (1996 $million)		
Los Angeles - San Francisco/San Jose	$256.8	$261.8
With Extensions	$351.1	$357.9
Base Funding Requirements		
Statewide Sales Tax Option		
Los Angeles - San Francisco/San Jose	1/4¢	3/8¢
With Extensions	1/4¢	3/8¢
Gas Tax (per gallon) Option		
Los Angeles - San Francisco/San Jose	5¢	7¢
With Extensions	6¢	8¢
Length (miles)		
Los Angeles - San Francisco/San Jose	460	460
Los Angeles - San Diego	158	158
Stockton - Sacramento	58	58
Total	**676**	**676**
Speed (mph)		
Maximum Speed (mph)	220	310
Average Speed (mph)	160	219

Table 8.9 Recommended System Characteristics (continued)

	VHS System	Maglev System
Express Travel Times (hours : minutes)		
Los Angeles – San Francisco	2:49	2:03
Los Angeles – San Jose	2:30	1:50
Los Angeles – San Diego	1:12	0:58
Los Angeles – Sacramento	2:31	1:53
San Francisco – Sacramento	1:21	1:03
Fresno - San Jose	1:04	0:44
Fresno – Los Angeles	1:29	1:07
Fresno – San Francisco	1:21	0:58
Bakersfield – San Francisco	1:52	1:19
Bakersfield – Los Angeles	0:58	0:45
Sacramento – San Jose	1:04	0:50

Notes: (1) Figures may not add due to rounding.
(2) Capital costs assume the new alignment option through the Central Valley.

Figure 8.1 Recommended System



Either the next generation of VHS steel-wheel-on-rail or Maglev technology will provide frequent service and fast travel times. Trains will travel at maximum operating speeds of nearly 220 mph for VHS technology or 310 mph for Maglev. Average operating speeds will, of course, be lower at about 150 mph for VHS technology between Los Angeles and San Francisco. Speeds in urban areas will be restricted to a maximum of about 125 mph. These speeds permit express travel times between San Francisco and Los Angeles of about 2 hours and 49 minutes with VHS technology and a little over two hours with Maglev.

Once fully operational, farebox and other revenues will exceed operating costs by a healthy margin. Capital costs range from $20.7 billion for the VHS system to $28.9 billion for a Maglev system. Most of the capital costs will need to be supported by a public funding source, such as a sales or gas tax, although the extensions will be financed predominately by system revenues. However federal and local monies, as well as private sector participation, also should contribute to the system's funding, thereby reducing the state's contribution to the greatest extent possible.

The Commission's final alignment recommendation described above differs from the route recommended in its draft *Summary Report* (September 1996). In response to public comments, the Commission altered their preferred route crossing of the Tehachapi Mountains from the I-5 Grapevine alternative to an Antelope Valley option. They also changed the recommended corridor between Los Angeles and San Diego from the coastal LOSSAN route to an inland I-15 Corridor. While the changes have considerable public support and serve areas projected to experience significant future population and economic growth, the two changes added nearly 80 miles to the alignment and increased the capital costs by about $2 billion for VHS technology. The changes also reduced the projected ridership and surplus operational revenues due to slightly longer travel times between the major transportation markets.

Nevertheless, the base financing requirements did not change. However, if using retail sales tax, the Authority would need to identify another source to make up a projected $325 million revenue shortfall for construction of the recommended VHS system (including extensions).

The new High Speed Rail Authority will oversee the next steps in the implementation process which include obtaining funding authority from the Legislature or voters, negotiation with a private partner, and the environmental clearance process. These steps are described in more detail in the following section.

9.0 Action Plan

- Enter into cooperative or joint development agreements with local governments or private entities;
- Set the fares and schedules for the system; and
- Relocate highways and utilities.

A key provision of SB 1420 concerns the funding of the High Speed Rail Authority. Through SB 1420, the Legislature will authorize a modest appropriation to sustain the Authority and its staff through preparation of the high-speed rail plan and financing scheme. Should the proposed system and financing scheme fail to gain approval either through the Legislature or by the voters, however, funding for the Authority will not continue. Furthermore, the Authority would sunset should it fail to gain approval of a high-speed rail funding measure by November 2000.

9.3 Project Phases

There are five major phases of the high-speed rail implementation process that will occur before the start of revenue operations. These include conceptual planning, preliminary engineering and environmental clearance, final design, construction, and startup testing. The phases are described below in roughly sequential order, although in actuality most phases will overlap to varying degrees. Also provided below are order of magnitude estimates of the resources required for each phase.

9.3.1 Conceptual Planning

This first phase of high-speed rail implementation is mostly complete, comprised by the work of the Intercity High Speed Rail Commission. The purpose of conceptual planning was to investigate high-speed rail alternatives throughout the State to identify the most promising alternatives to carry forward to the preliminary engineering phase.

Over the past two years, the Commission has overseen four technical studies, undertaken a public participation program, and developed a conceptual high-speed rail system. This Summary Report and Action Plan presents their findings and recommendations to the public, the Governor, and Legislature. The technical work encompassed an investment grade ridership and passenger revenue forecast, an evaluation of potential high-speed rail corridors and environmental constraints, an economic impacts study and mode cost comparison, and an evaluation of financing and institutional options. Outputs of the studies included route options, ridership and revenue forecasts, capital costs, operational and maintenance costs, travel times, environmental impacts, a cost/benefit analysis, and a